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ABSTRACT

In this test for age-related effects of perceptual interference under different task conditions, 240 subjects, 60 each in kindergarten and grades 1 through 3, learned the positions of 5 cards upon each of which 3 stimulus attributes--a word, a color, and a shape--were presented in different descending orders. Two stimulus conditions were employed, one in which words and colors had been demonstrated to cause perceptual interference (for example, the pairing of the color yellow and the word "sky"), and one in which they had not. Task conditions were varied; in one condition, students were instructed to learn the position of colors; in the other, no attribute was designated as relevant to the task. After position learning was complete, a test for the position of each stimulus attribute was administered by means of 15 test cards, each of which contained only one of the stimulus components. Results indicated that perceptual interference occurred in both task conditions among grade 2 and grade 3 subjects, but not among grade 1 and kindergarten subjects. It is concluded that the effects of perceptual variables must be carefully considered before inferences are made regarding the development of cognitive strategies. (RH)

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The Development of Stroop Like Interference Effects
In Childrens' Component Selection and Incidental
Learning

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Abstract

An experiment was conducted in which 240 subjects, 60 each in kindergarten, grade 1, grade 2, and grade 3, learned the position of five cards. Each card was composed of a word, a color, and a shape. Two stimulus conditions were employed, one in which the words and colors have been demonstrated to cause perceptual interference and one in which they have not. Two task conditions were employed, one in which instructions to learn the position of colors were given and one in which no attribute was designated as task relevant. After position learning was complete, a test for the position of each attribute was given. Appropriate statistical analyses were conducted on the 4 (grades) x 2 (interference-noninterference) x 2 (task) x 3 (nested word, color, and shape recall) Factorial Design. Results demonstrated that perceptual interference occurred in both task conditions in the grade 2 and grade 3 subjects. The effects of perceptual variables must be carefully considered before inferences are made regarding the development of cognitive strategies.

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Two types of experimental tasks (Hagen & Hale, 1973; Hale, 1979) have been used extensively to explore the development of selective attention in learning. In both types of studies, children of different ages are asked to learn the position of stimuli that are composed of two components, such as shape and color. Each stimulus contains different values of the components. In the incidental learning paradigms, subjects are instructed explicitly to learn the position of one of the components. In the component selection tasks, subjects are instructed to learn the position of the stimulus as a whole and neither component is designated as task relevant. The children are then tested for recall of the position of each separate component value used during learning. In the initial incidental studies (Druker & Hagen, 1969; Hagen, 1967; Hale & Taweel, 1974), recall for the incidental information was lower than that for the task relevant material and decreased with age. Hagen and Hale (1973) concluded that, with age, children become better able to filter out irrelevant information and thus selectively attend to the task

relevant information. This increase in selective attention allows for more efficient learning. In the component selection studies (Hale & Taweel, 1974; Hale & Green, 1976), children of ages 5 or 6 typically recall the position of one stimulus component (dominant) to a greater degree than the position of the other component (nondominant). With age, recall for the position of the nondominant component increased to the level of the dominant component. In comparing the discrepant results of the two types of paradigms, Hale (1979) argued that children become better able to discriminate situations in which it is advantageous to employ selective attention. He further argued that in nonconstrained task situations, such as the component selection task, children have a disposition to attend to as much information as possible to aid in learning.

It has been demonstrated that recall in the incidental paradigm is affected by the perceptual salience of the stimulus components used. Research has shown that with or without instructions to recall a particular kind of relevant component, older children recall more irrelevant, incidental information than younger children (Odom, Cunningham, & Astor-Stetson, 1977). It has also been demonstrated that both older and younger children recall incidental information that is highly salient much better than information that is not (Odom, 1972; Odom & Lemond, 1975). Finally, Odom (1972) demonstrated that different stimulus components have different salience values at different ages. These findings suggest that the perceptual attributes of stimuli

have an important effect on selection processes that operate in these "selection" learning tasks.

Perceptual interference effects have been demonstrated in children's naming of colors and colors associated with objects in Stroop or Stroop like paradigms (Campbell, Douglas, & Morganstern, 1971; Cohen & Douglas, 1972; Peters, 1977). Stroop like interference has been demonstrated in adult paired-associate learning (Solso, 1968). However, the development of Stroop type interference has not been investigated with school aged children in a learning task.

The present experiment was designed to test for age related effects of perceptual interference under a task condition in which selective processes have normally been invoked by older children versus one in which selective processes normally have not been demonstrated. If the selective process is determined by perceptual interference rather than the disposition to use a particular cognitive strategy then selective recall should be found in the interference condition of the component selection task. The developmental changes in the perceptual salience of the stimulus components were also assessed.

Method

Subjects

The sample included 60 subjects at kindergarten; mean age 5 yrs. 5 mo., s.d. 3.62. There were 60 subjects at grade 1; mean age 6 yrs. 5 mo., s.d. 3.66. There were 60 subjects at grade 2; mean age 7 yrs. 6 mo., s.d. 3.97, and 60 subjects at grade 3; mean age

8 yrs. 6mo., s.d. 5.10. Of the total sample, 52% were male and 48% were female. All subjects were drawn from two elementary schools in the Washoe County School District of Nevada. Of the 240 subjects, 224 were white, six were black, and 10 were hispanic. All subjects were of middle socioeconomic status.

Three kindergarten subjects and one grade 1 subject failed to reach the learning criterion. They were replaced and their data was discarded. The subjects were divided among the various experimental subgroups as specified below in the section on experimental design.

Materials

The materials consisted of two sets of 25 cards. In each of the two sets of 5 x 9 in. cards, there were five "exposure" cards, five "cue" cards, and 15 "test" cards.

Each of the five exposure cards, in both sets, had a word, a color, and a shape on them. There was a different descending order of color, shape, and word for each of the five cards. The cue cards were identical to the exposure cards for both sets. Each of the 15 test cards, in both sets, contained only one stimulus component, either a word, a color, or a shape. The same five words, colors, and shapes were used in both stimulus sets. The five words were "PUMPKIN," "FIRE," "SUN," "GRASS," and "SKY." The five colors were orange, red, yellow, green, and blue. The five shapes were square, circle, octagon, star, and diamond.

In one set of cards, the noninterference stimuli, words were paired with colors that did not produce the Stroop phenomenon

(Klein, 1964) or interfere with recall in a paired associates task (Solso, 1968), for example, "SKY" was printed on the color blue. The other set of cards was used in the interference condition in which words were printed on colors that have been empirically demonstrated to cause interference effects, for example, the word "SKY" was printed on the color yellow.

Procedure

Equal numbers of subjects, in each grade group, were randomly assigned to one of four experimental conditions. In the first condition, the subjects were exposed to the noninterference stimuli and were given component selection instructions. In the second condition, the subjects were exposed to the noninterference stimuli and were given incidental learning instructions. In the third condition, the subjects were exposed to the interference stimuli and given component selection instructions. In the fourth condition, the subjects were exposed to the interference stimuli and were given incidental learning instructions.

Subjects assigned to the component selection task were instructed to learn the position of each of the five cards. Subjects assigned to the incidental learning task were explicitly instructed to learn the position of each of the five colors.

An experimental session was conducted in two phases, a learning phase and a test phase. For an individual session, the subject was seated across from the experimenter facing a plexiglass stand, which contained the five cards side by side, with a movable opaque cover.

In the learning phase, the exposure cards were exposed to the subject for a 5 sec. inspection period. After the inspection period, the exposure cards were covered again and learning trials were started. The five cue cards were held up into the subject's view, each in turn, and the subject pointed to the position of the card in the array. The exposure card that was pointed to was then shown to the subject. A trial consisted of a test of position learning for each of the five exposure cards. The five exposure cards remained in the same position throughout the experimental session. Criterion was defined as two consecutive errorless trials. The order of presentation of the cue cards was randomized across trials.

After the learning phase, the test phase was started. The subject was exposed to each of the 15 test cards, one after the other, and pointed to the position that was believed to be correct. No feedback was provided during the test phase. Two random orders of test card presentation were used.

Experimental Design

A 4 (Grades K, 1, 2, 3) x 2 (Interference and Non-interference) x 2 (CST vs. ILC) x 3 (recall for word, color, shape) Factorial Design was used with a repeated measure on recall. The design yielded 12 subgroups of 15 subjects each.

Results

Learning Rates

An analysis of variance was conducted on learning trials to criterion with grade, interference, and task as between subject

factors. A significant main effect was found for the grade factor ($F, (3, 168) = 34.77, p < .001$). A test of the simple main effects on trials to criterion with the Scheffe procedure demonstrated that grade 3 ($M = 4.11, s.d. = 1.90$) and grade 2 ($M = 4.05, s.d. = 2.00$) subjects reached criterion sooner than kindergarten ($M = 6.78, s.d. = 2.02$) and grade 1 ($M = 6.02, s.d. = 2.15$) subjects.

Component Selection Recall

Table 1 shows that a test with MANOVA revealed a significant effect involving the within-subject factor of component selection recall $\times$ grade $\times$ interference $\times$ task ($F, (6, 416) = 12.93, p < .001$).

The Scheffe procedure was applied to a set of orthogonal contrasts of simple interaction effects between the stimulus components within grades. Figure 1 shows, that in the component selection task (CST), the recall for color position by kindergarten students was greater than that of words and shapes both in the interference condition ($F (1, 416) = 11.77, p < .001$) and in the noninterference condition ($F (1, 416) = 9.61, p < .01$). Figure 1 further shows, that in the incidental learning task (ILC), color position recall was also greater than that for words and shapes in both the interference condition ($F (1, 416) = 8.92, p < .01$) and in the noninterference condition ($F (1, 416) = 9.41, p < .001$). Figure 2 shows, that in the component selection task, the pattern of stimulus component recall for grade 1 subjects paralleled that of kindergarten subjects in that recall for color position by grade 1 subjects was greater than that for words and

shapes in both the interference condition ($F(1, 416) = 7.95, p < .01$) and in the noninterference condition ($F(1, 416) = 10.43, p < .01$). Again in Figure 2, one sees, that in the incidental learning condition, recall for color position was greater than that for words and shapes in the interference condition ($F(1, 416) = 8.22, p < .01$) and, again, in the noninterference condition ($F(1, 416) = 9.47, p < .01$).

In contrast to the performance of kindergarten and grade 1 subjects, Figure 3 shows that, in the component selection task, the recall for word position by grade 2 subjects was higher than that for both color and shape ($F(1, 416) = 11.27, p < .001$) in the interference condition but higher only than shape in the noninterference condition ($F(1, 416) = 7.82, p < .01$). In the incidental learning task, Figure 3 shows that color position was recalled more than word or shape ($F(1, 416) = 10.56, p < .01$) positions in the interference condition but in the noninterference condition, recall for both words and colors was greater than that for shapes ($F(1, 416) = 7.77, p < .01$). Figure 4 shows that, in the component selection task, position recall of grade 3 subjects was greater for words than that for colors or shapes ($F(1, 416) = 9.44, p < .01$) in the interference condition. In the noninterference condition, grade 3 subjects showed greater recall for the position of words and colors than that for shapes ($F(1, 416) = 9.38, p < .01$). Figure 4 further shows that, in the incidental learning task, position recall was greater for colors than that for words or shapes ($F(1, 416) = 11.01, p < .001$) in the

interference condition. In the noninterference condition, position recall for colors and words exceeded that shown for shapes ($F(1,416) = 9.37, p < .01$). The recall patterns were similar for grade 2 and grade 3 subjects.

Discussion

Results demonstrated that perceptual interference from Stroop like stimulus components was evident in the recall patterns of grade 2 and grade 3 children but not in children in grades 1 or kindergarten. Figures 3 and 4 show that high recall for both words and colors was demonstrated in the noninterference conditions of both the component selection task and the incidental learning task. In the interference conditions of both tasks, one of the stimulus components, word or color, was recalled to a greater degree than the other. The differential use of selective strategies in the component selection paradigm versus the incidental learning studies generally have been construed as originating from the different task demands placed on the subjects. Hale and Taweel (1974) performed an experiment in which both the component selection task and an incidental learning task were used. Older children showed selective recall of stimulus components in the incidental task and high recall for both components in the component selection task. Hale and Taweel (1974) argued that the instructions employed in the component selection task allowed the older children to exercise their natural disposition to use a broad attentional strategy. The present results agree with those experiments on perceptual

salience (Odom, 1972; Odom, Cunningham, & Aston-Stetson, 1977; Cunningham & Odom, 1986) that indicate that the employment of a particular attentional strategy in a learning task is dependent on the constraints provided by the perceptual organization of the stimulus components in the stimulus configuration. In the present experiment, the perceptual characteristics of the stimuli determined the use of a selective strategy and not the different instructions provided in the two tasks. Clearly, the interaction between perception and cognition must be closely scrutinized before inferences are drawn about the development of cognitive strategies.

Odom and his colleagues (1972; 1975; 1977) have demonstrated that stimulus components differ in their perceptual salience. Also, a particular component, such as shape, can be more salient for one age group than for another. A comparison of the component recall scores in the component selection task in Figures 1, 2, 3, and 4 show that, as children progress through school, words become a more salient stimulus than colors. In the component selection task, children were free to select any feature of the stimulus to use as a discriminative stimulus. In the noninterference condition, younger children showed a greater recall for colors than for words or shapes but, in grades 2 and 3, children recalled more words than colors or shapes. For those children who did not have the stimulus words in their reading vocabulary, words may have functioned as complex nonsense syllables. For children with the words in their reading vocabulary, the words may have been

potent discriminative stimuli, thus changing the salience hierarchy of the stimulus components.

The present results also bear on the selective attention hypothesis of Hagen and Hale (1973). Hagen and Hale (1973) hypothesized that older children are more capable than younger children in filtering out irrelevant stimuli thus enhancing attention to task relevant information. When Figures 1 and 2 are compared with Figures 3 and 4, in the incidental task under conditions of noninterference, recall for the incidental material was greater for the children in grades 2 and 3 than the children in grades 1 and kindergarten. Many experiments (Hale & Piper, 1973; Odom, 1972; Odom et al., 1977) have produced results that have conflicted with the selective attention hypothesis.

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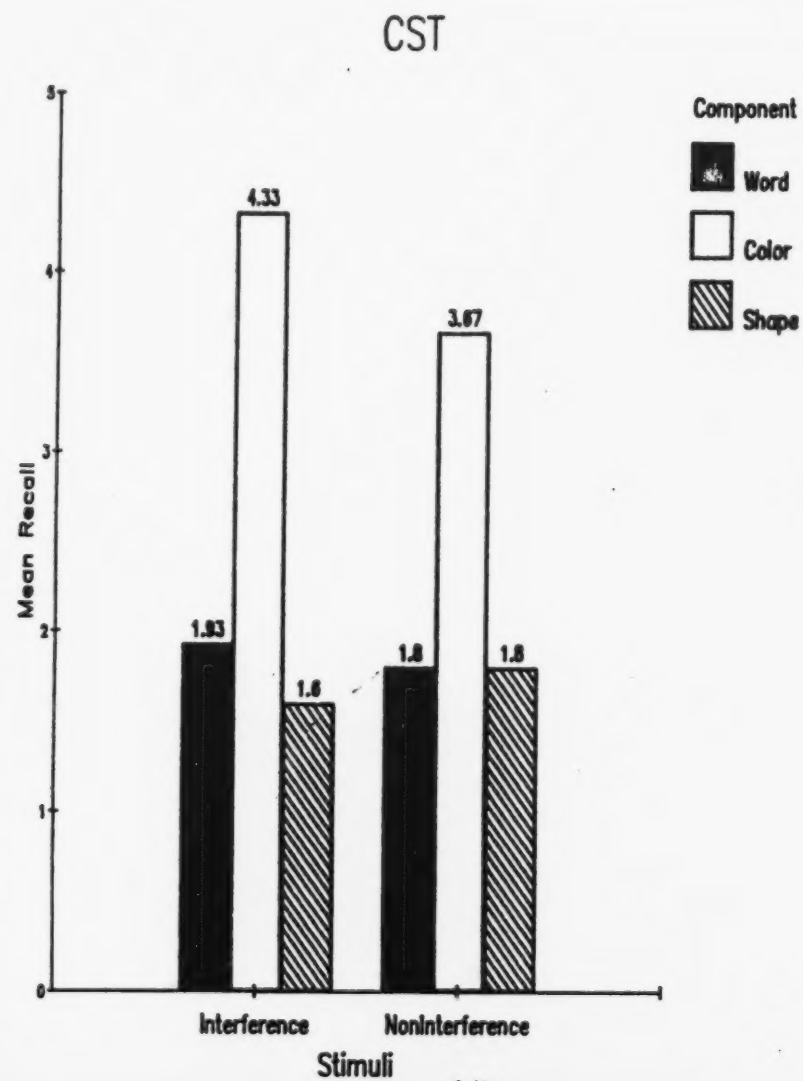
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Table 1. Summary of Multiple Analysis of Variance showing effects of Sex, Grade, Interference, and Task on Total Recall for position.

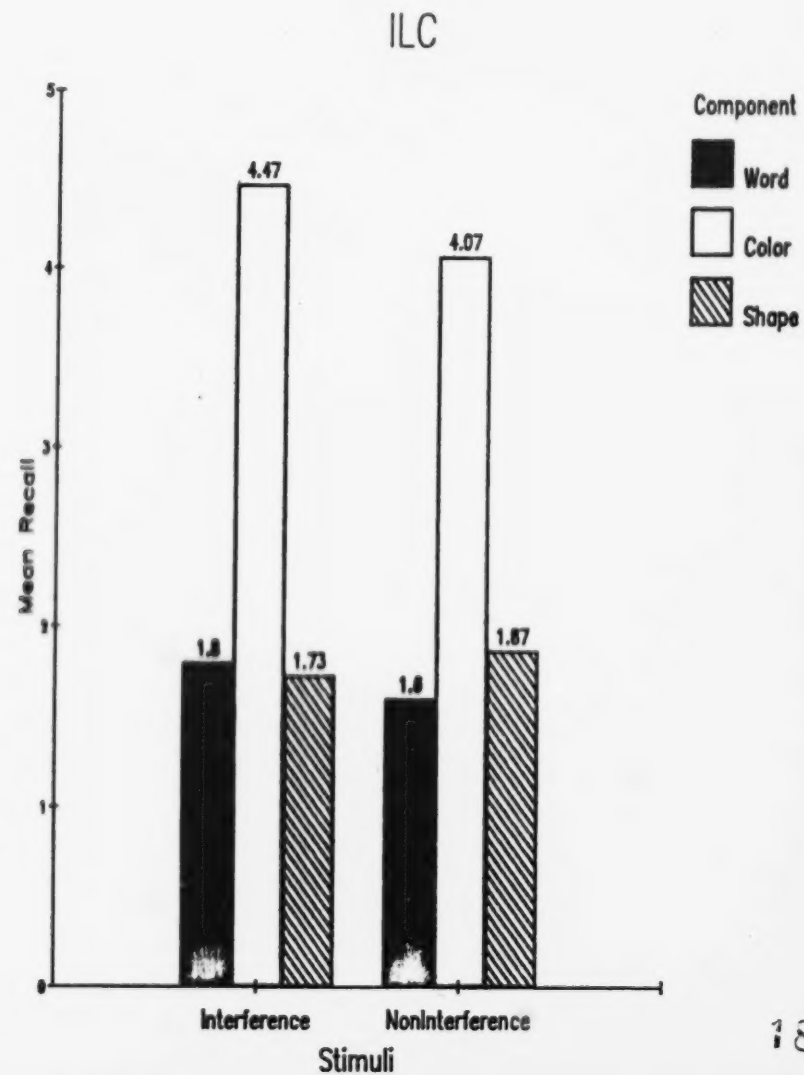
Source	df	SS	MS	F	sign.
Mean	1	5965.62	5965.62	5142.77	.001
Sex (S)	1	0.01	0.01	0.01	
Grade (G)	3	21.73	7.24	6.24	.025
Interference (I)	1	31.74	31.74	27.36	.001
Task (T)	1	1.02	1.02	0.88	
S x G	3	1.85	0.62	0.53	
S x I	1	2.11	2.11	1.82	
G x I	3	18.67	6.22	5.36	.025
S x T	1	0.10	0.10	0.09	
G x T	3	2.37	0.79	0.68	
I x T	1	3.78	3.78	3.26	
S x G x I	3	12.48	4.16	3.59	
S x G x T	3	9.74	3.25	2.80	
S x I x T	1	0.06	0.06	0.05	
G x I x T	3	1.99	0.66	0.57	
S x G x I x T	3	5.43	1.81	1.56	
ERROR	208	241.25	1.16		
Component Recall (R)	2	266.61	133.31	146.49	.001
R x S	2	4.00	2.00	2.20	
R x G	6	161.52	26.92	29.58	.001
R x I	2	27.33	13.67	15.02	.001
R x T	2	41.61	20.81	22.87	.001
R x S x G	6	7.61	1.27	1.40	
R x S x I	2	1.89	0.94	1.03	
R x G x I	6	72.29	12.05	13.24	.001
R x S x T	2	4.73	2.37	2.60	
R x G x T	6	18.18	3.03	3.33	
R x I x T	2	33.97	16.99	18.67	.001
R x S x G x I	6	5.11	0.85	0.93	
R x S x G x T	6	101.26	16.88	18.55	.001
R x S x I x T	2	3.82	1.91	2.10	
R x G x I x T	6	67.71	11.28	12.39	.001
R x S x G x I x T	6	7.80	1.30	1.43	
ERROR	416	378.39	0.91		

Figure 1

Stimulus Component Recall Kindergarten



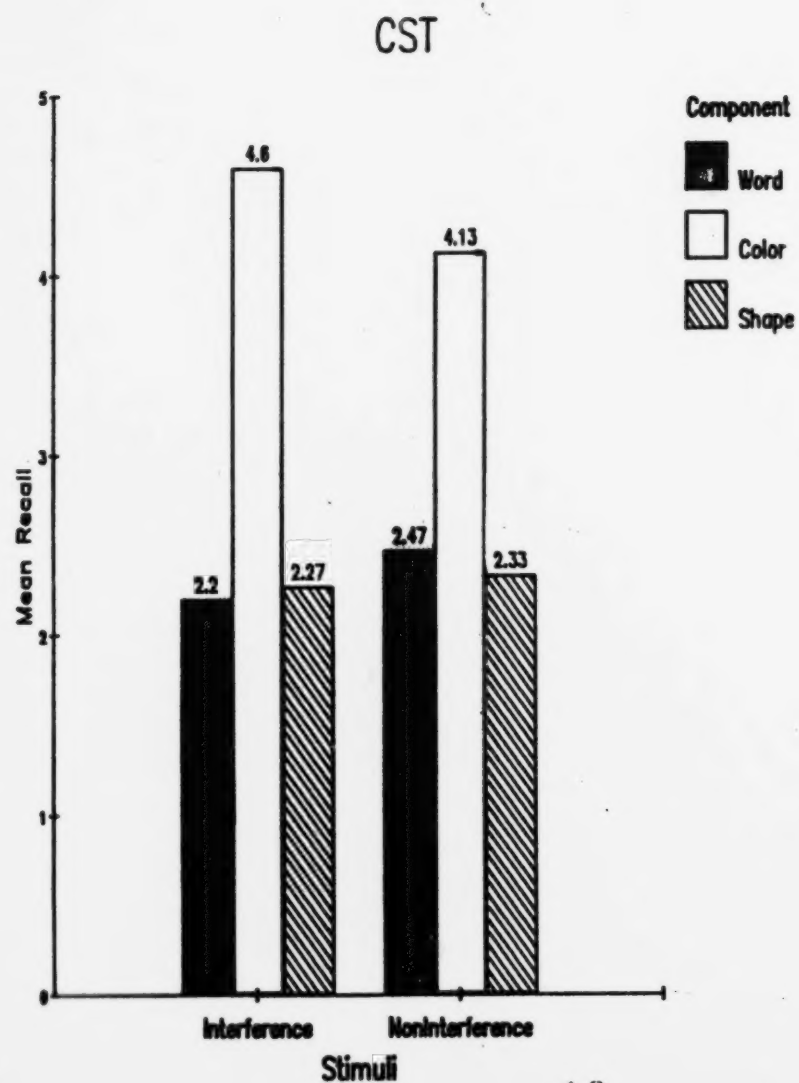
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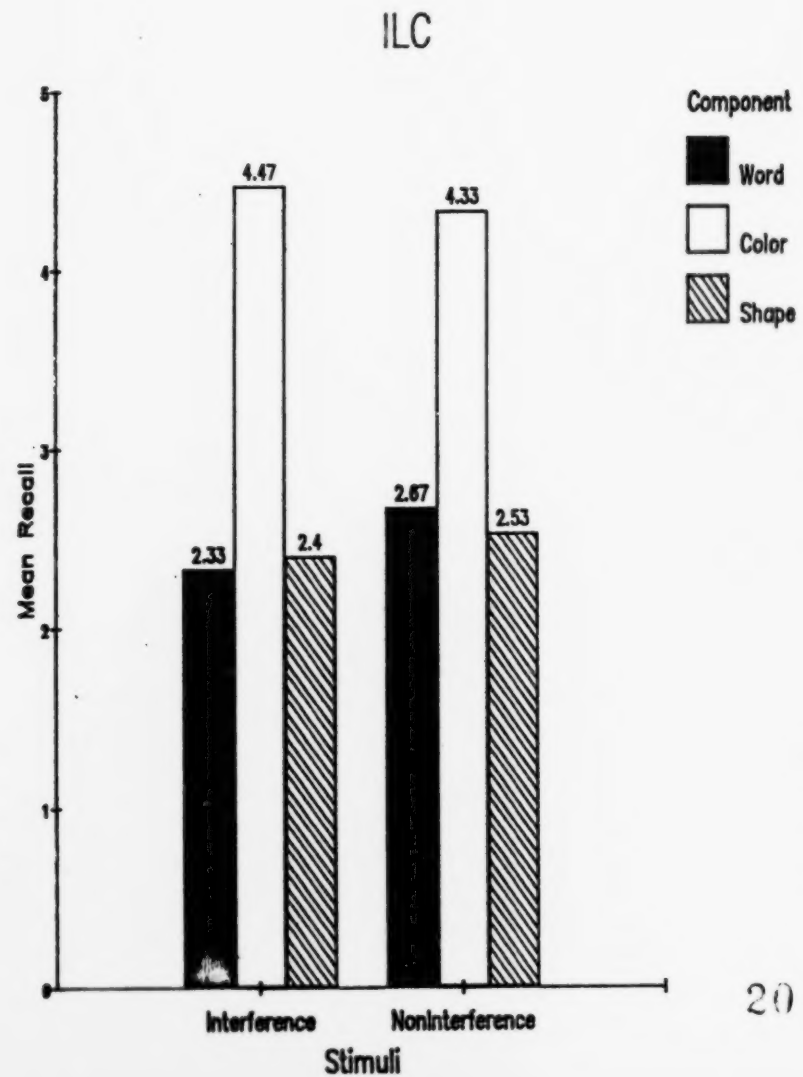
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Figure 2

Stimulus Component Recall Grade 1



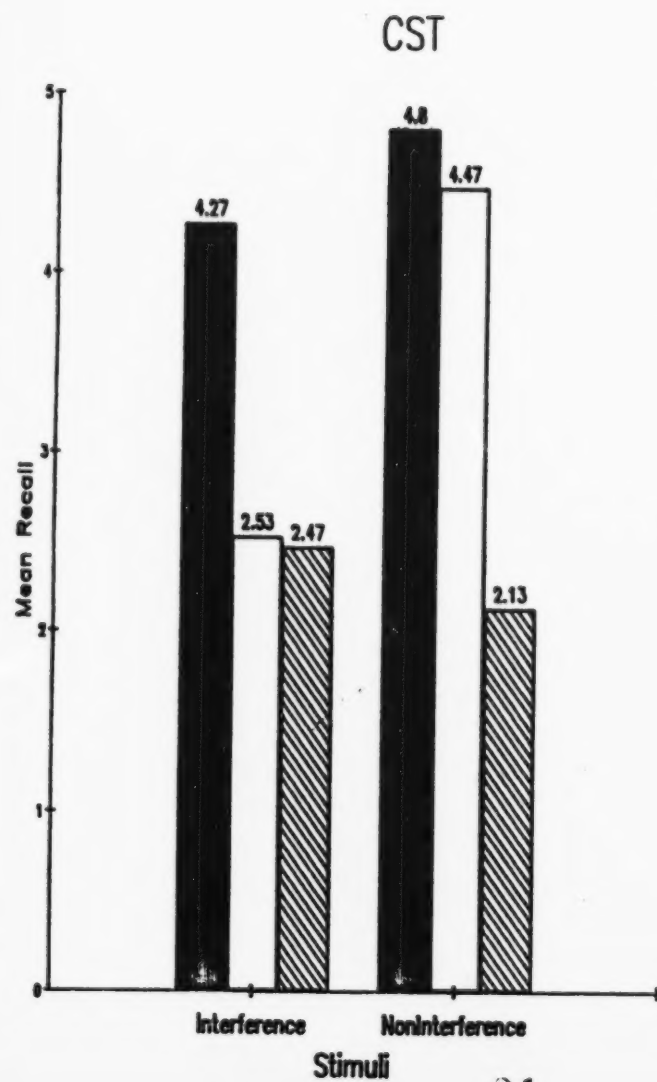
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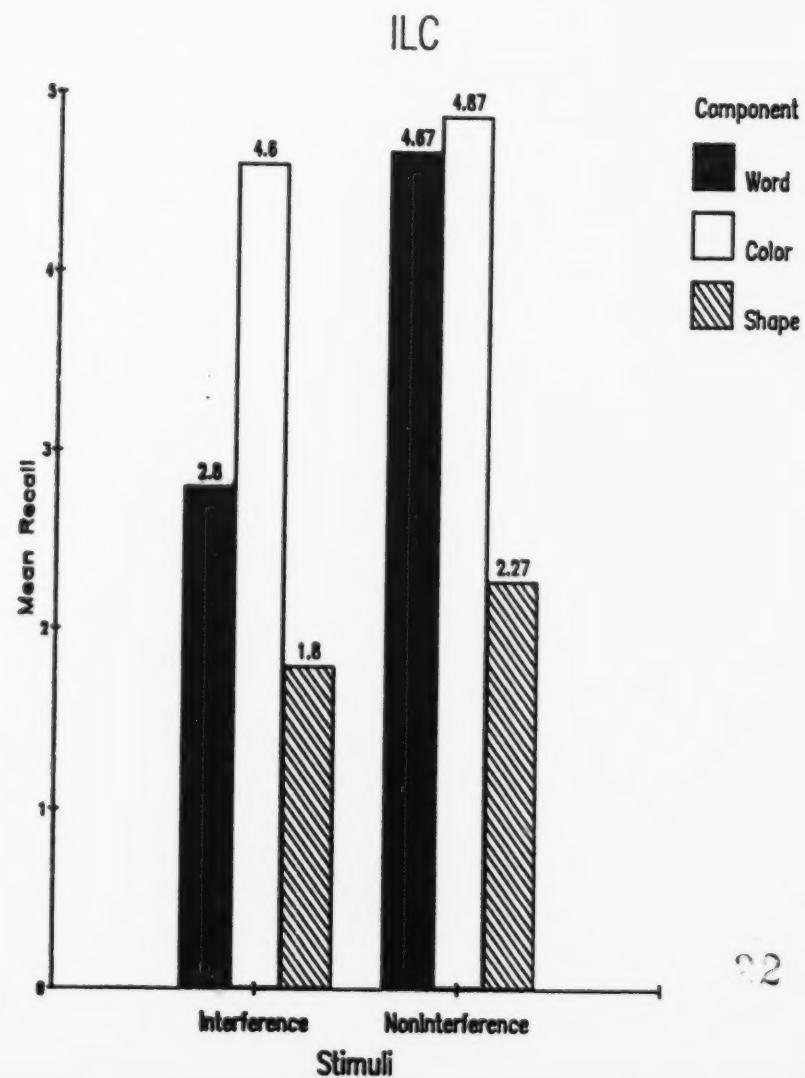
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Figure 3

Stimulus Component Recall Grade 2



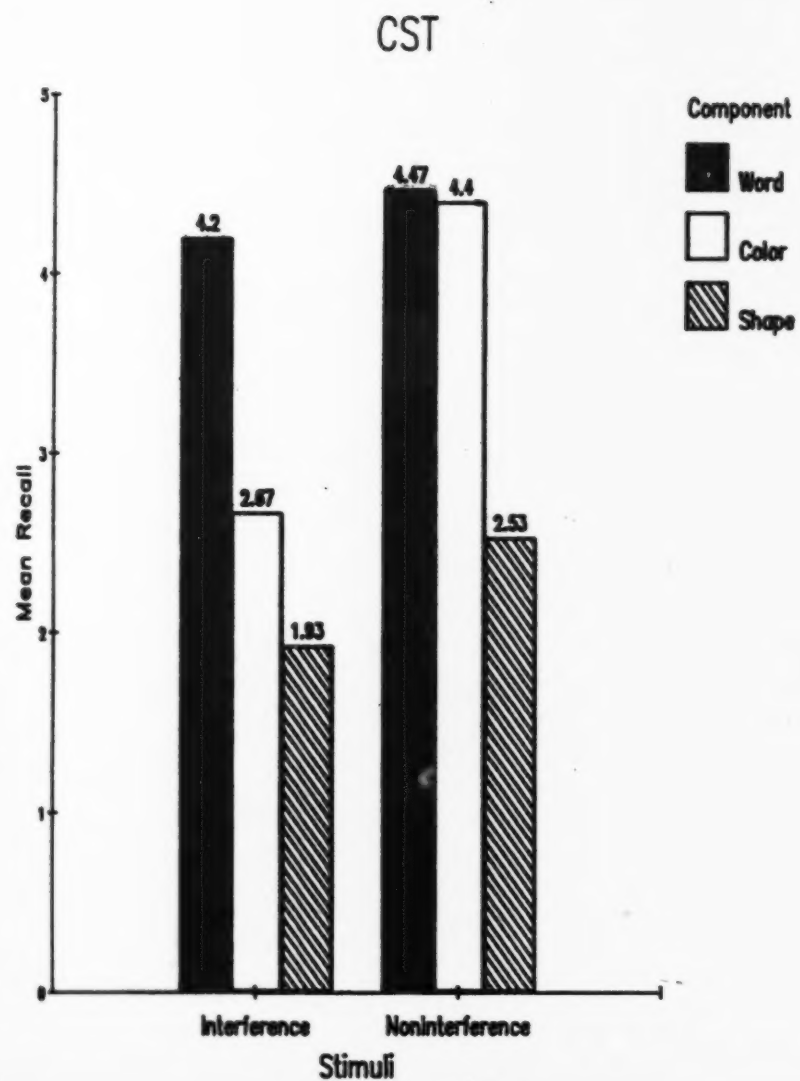
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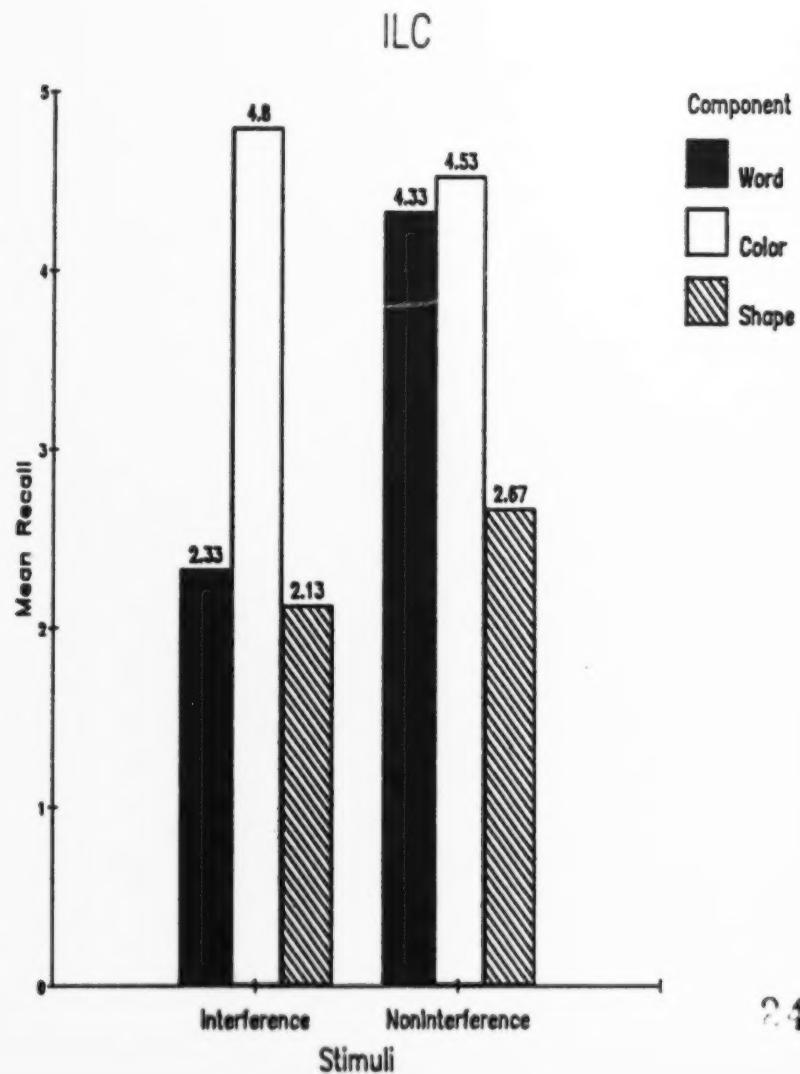
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Figure 4

Stimulus Component Recall Grade 3



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